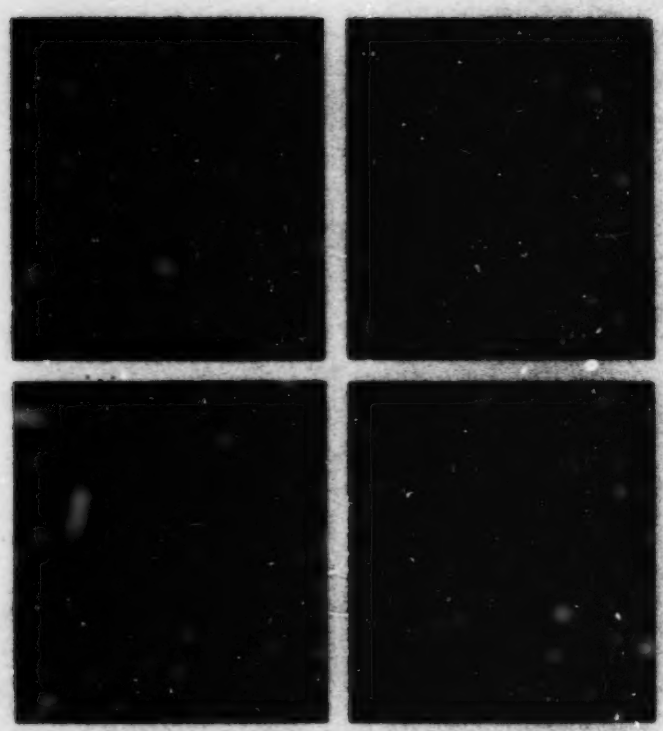

a cost comparison of conventional implements, air seeders and aircraft for seeding, spraying and fertilizing

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A COST COMPARISON OF CONVENTIONAL IMPLEMENTS, AIRSEEDERS AND AIRPLANES FOR SEEDING, SPRAYING AND FERTILIZING

Len Fullen

Alberta Agriculture

June, 1984

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Len Fullen

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Section I

INTRODUCTION

Increasing costs for fertilizer, chemicals, fuel, repairs, labour and farm machinery have resulted in farmers being keenly interested in and aware of new methods of farming that may be more efficient and more economical. Development of new equipment such as the airseeder, and further refinement of equipment such as the airplane used for applying chemicals, fertilizer or even seed has given the average farmer a lot to consider when deciding how best to produce a crop on his or her own farm.

To assist farmers in their decision making, individuals using various methods of seeding, fertilizing and spraying were surveyed during the late winter and early spring of 1983.

Objectives of the Study

The primary objective of the study was to obtain data from farmers using various methods for seeding, fertilizing and spraying that would show how much advantage or disadvantage there might be to using one system instead of another. The principal systems to be evaluated were:

a) conventional ground implements for seeding, fertilizing and spraying,

b) airseeders for seeding and fertilizing, and

c) airplanes for seeding, fertilizing and spraying

Although the main emphasis was on a comparison of ownership and operating costs, questions were also asked regarding the performance or functional aspects of each system.

Sources of Data

Participants on the survey were selected in three different ways:

a) district agriculturists were asked for the names of three farmers in their districts who used only conventional ground implements in their seeding, spraying and fertilizing operations during 1982 and who would likely be willing to assist with the study,

b) equipment dealers were contacted to obtain the names of farmers across the province who had experience with airseeders, and

c) aerial applicators were contacted for the names of some of their farmer clients who could supply information about seeding, fertilizing or spraying by aircraft.

The questionnaire was divided into three parts. The first asked general questions such as the methods used on the farm during 1982 for seeding, fertilizing and spraying, whether equipment was owned or rented, in what form and at what time of year nitrogen was applied and why one method was selected over another.

The second part asked for agronomic data relating to a specific field of either a cereal or oilseed crop grown on the farm during 1982. Questions were asked regarding variety of crop, acreage planted, seeding date, seeding rate, soil type and texture, growing season rainfall, and yield obtained. Specific questions of this nature were asked so that a comparison could be made between similar fields that had been seeded, fertilized or sprayed with different types of equipment. We also wanted to be able to note possible reasons for some of the data that would likely appear in the third part of the questionnaire, i.e. information regarding the number of times the field was worked prior to seeding, the size and type of equipment used, hours of labour and quantities and costs of seed, fertilizers and chemicals.

Of the 150 farmers to whom questionnaires were mailed, 68 returned them. Only the first two parts were usable from two of these and a third questionnaire was unusable.

Participants were asked to submit data for up to four fields where different crops or different production methods had been used. Usable data were obtained for 172 fields, covering nine different crops.

Section II

SURVEY RESULTS - PART A GENERAL INFORMATION

Part A of the questionnaire asked general questions about the farming operation, such as land location, method(s) of seeding, fertilizing and spraying in 1982, whether equipment was owned, whether work was custom done, etc.

This section of the publication summarizes information supplied by the respondents. A copy of the questionnaire is provided in the appendix for readers who wish to know how questions were actually worded.

Regional location of respondents

From the farmer's description of his land location, data were sorted into six provincial regions, as shown in Figure I. Approximately 72 per cent of the respondents were located in Regions 1, 2 and 3 - an area roughly south of Wetaskiwin to the U.S. border.

Seeding method(s) used (A5)

Farmers were asked what seeding method(s) they used in 1982. Of the 65 respondents, 69 per cent used conventional equipment, 18 per cent used airseeders and five per cent used airplanes. The remaining nine per cent used some combination of the three methods[1].

Fertilization method(s) used (A6)

Sixty-six per cent of respondents used conventional equipment for fertilizing, while 19 per cent used airseeders and three per cent used airplanes. An additional 12 per cent of respondents used a combination of conventional equipment and airseeders for fertilizing during 1982.

---

1 Percentage totals may be greater or less than 100 as a result of rounding to the nearest whole number.

FIGURE I: DISTRIBUTION OF SURVEY RESPONDENTS ACCORDING TO REGION

Region	Percentage of Survey Respondents
1	10.4
2	37.3
3	23.8
4	7.5
5	13.4
6	7.5

Spraying Method(s) Used (A7)

Farmers using conventional ground implements for spraying accounted for 63 per cent of the total, while 21 per cent used airplanes and another 16 per cent used conventional equipment and airplanes.

Type of conventional drill used (A8)

Of the farmers who used conventional seeding equipment, 30 per cent used a double disc press drill, 19 per cent used a hoe press drill, eight per cent used a hoe drill with no press and 10 per cent used a disker. The remainder used an assortment of other equipment in insignificant numbers.

Airseeder setup (A9)

If they used airseeders, respondents were asked how the airseeder was set up; 27 per cent used a harrow-packer drawbar with their airseeder, while another 13 per cent used harrows with a packer pulled separately, resulting in only 40 per cent of respondents who used a packer assembly in conjunction with their airseeder.

NOTE: Engineers with Alberta Agriculture believe that the number of farmers using packers with their airseeders is closer to 75 per cent on a province-wide basis today.

Fertilizer equipment (A10)

Farmers using conventional equipment for fertilizing were asked if they had their own equipment or whether the fertilizer was custom applied. Forty-six per cent owned their equipment, 21 per cent had all fertilizer custom applied, 11 per cent used both their own equipment and custom services, 12 per cent rented or leased equipment and 11 per cent used their own equipment and rented equipment.

Type of fertilizer used (A11)

Thirty-five per cent of the farmers participating in the study applied nitrogen as anhydrous ammonia, 45 per cent used a granular form of nitrogen and the

remainder used either liquid nitrogen or some combination of anhydrous, granular or liquid.

Time of fertilizer application (A12)

Twenty-two per cent of the study participants applied all their nitrogen in the fall, 27 per cent put on all their nitrogen in the spring prior to seeding and another 11 per cent applied all nitrogen at time of seeding. The remainder applied nitrogen in both fall and spring.

Reasons for purchasing airseeders

Farmers who used airseeders purchased them for a variety of reasons. The most frequently mentioned reason was for banding fertilizer. Other reasons were to reduce field time, lower input costs, ease of transport, seeding in stubble while saving trash, availability of a low-priced prototype, ability to seed almost any seed, and to reduce dependency on fertilizer companies for liquid fertilizer and nurse tanks. All but one of the respondents were located in regions 1, 2 and 3.

Years of experience with airseeders

Farmers on the study had from one to four years of experience with airseeders, as shown below:

Yrs. experience	Percentage of respondents
1	21
2	43
3	21
4	14

Reasons for liking airseeders

The most commonly stated reasons for liking the airseeder system were success in banding fertilizers and ease of transport.

Other commonly stated reasons were ability to cover ground faster than with conventional equipment, the larger volume of seed and fertilizer tanks, and the

ability to seed into standing stubble without incorporating too much trash.

Reasons for disliking airseeders

The most common reason for disliking the airseeder system was the problem of depth control and the need for constant monitoring and adjustment. Other reasons were the high maintenance cost of a diesel engine, uneven germination, moisture from melting frost running off the tank and down into the feed boot, and that the job of moving an auger to fill the hopper was too much work for one man alone.

Reasons for using airplanes to seed

Only two respondents stated their reasons for seeding with airplanes and these were for saving time, less dependency on the weather, the ability to farm more land and the economics when one considers a reduction in labour, lower investment in equipment, etc.

Years of experience seeding with airplanes

Because of weather conditions in 1982, there was apparently less seeding by airplanes than in most years. A few farmers on the study had used airplanes for seeding in the past but not during 1982. Three farmers stated that they had used airplanes for seeding for only one year. Three others had between two and eight years' experience and one farmer had 15 years' experience.

Reasons for liking aircraft for seeding

Reasons given by these seven farmers for liking airplanes for seeding were less dependency on the weather, reduced labour, less road travel, good even germination, nice stubble to lay swath on (even with a light crop) and excellent seed distribution.

Bad experiences with airplane seeding

When asked what bad experiences had occurred from seeding with airplanes, only two farmers answered. One experienced poor germination due to absence of moisture in the seedbed one year and another farmer believed that if he had used packers and/or harrowed the seedbed more his crop would have been better.

Reasons for fertilizing with airplanes

Time savings and elimination of the handling of fertilizer were the only reasons given for fertilizing with airplanes.

Experience fertilizing with airplanes

Only three farmers had experience fertilizing with airplanes. One had one year, another had four years and the third farmer had 15 years of experience.

Reasons for liking airplanes for fertilizing

Good results, speed of fertilization, the ability to fertilize on wet ground and reduced field travel were given as reasons why farmers liked fertilizing crops by airplane.

Reasons for disliking airplanes for fertilizing

The only reason given for not liking the use of airplanes for fertilizing was that it was thought to be more expensive per acre than conventional methods.

Reasons for spraying with airplanes

The fact that the soil was too wet for ground equipment was a reason given by 50 per cent of the respondents to the question of why they used airplanes for spraying. The ability to spray a dessicant on a crop and time savings were other common reasons given.

Experience spraying with airplanes

Nineteen respondents had experience with spraying crops by airplane. Sixteen per cent had only one year of experience, 63 per cent had two to five years' experience and 21 per cent had more than five years' experience.

Good experiences with airplanes for spraying

There were many good experiences and reasons for liking airplanes for spraying given by the respondents. The most frequent comments touched on the rapidity with which the job is done, the ability to spray during a rainy period, good, even coverage, time to do other coinciding operations, and the elimination of crop damage from wheel tracks.

Bad experiences with airplanes for spraying

Some of the more common reasons given for disliking aerial spraying were the problem of wind drift, trouble obtaining an airplane when it was needed, the increasing cost of aerial spraying while at the same time improvements to ground sprayers were being made, and "wide swathing" by the pilot resulting in uneven coverage.

Section III

SURVEY RESULTS - PART B AGRONOMIC DATA

Part B of the questionnaire referred to a specific field of either a cereal or oilseed crop grown during 1982. Participants were asked to supply data for between one and four fields where they grew different crops or varieties or used different cultural practices. As a result, the 67 farmers who completed the questionnaires supplied data on 172 fields, an average of 2.5 fields per farm.

Crops and varieties included in survey results

Nine different crops are included in the study. There were 51 fields and 11 varieties of barley, Klondike and Johnston being most common, followed by Elrose and Bonanza. Of the 41 fields of canola, 28 were the Polish variety Candle and the balance were Argentine varieties, with nine of these fields being Altex.

There were seven fields of Durum on the study, three fields of oats, one of mustard, one of rye, four of flax, two of winter wheat and 60 fields of spring wheat. Twenty-seven fields of spring wheat were Neepawa, and 10 were Park.

Field size in acres (B10)

Field sizes ranged from 30 acres to just over 1,000 acres. Thirty-five per cent of the fields were 80 acres or less, another 43 per cent were between 80 and 160 acres, 17 per cent were between 160 and 320 acres and three per cent were between 320 and 480 acres. There was one 500-acre field, one 600-acre field and one field over 1,000 acres.

Years of experience in growing the crop (B12)

The range in years of experience growing the various crops were as follows:

Crop	Range (years)
Barley	1 - 40
Canola	1 - 21
Durum	4 - 30
Oats	15 - 40
Mustard	6 - 6
Rye	5 - 5
Flax	4 - 25
W. Wheat	20 - 20
Sp. Wheat	2 - 45

Seeding date (B18)

Crop seeding dates ranged from May 01 to June 21, 1982 for spring seeded crops. Winter wheat was seeded on the 15th and 16th of September, 1981. Barley fields were seeded between May 04 and June 09, canola fields from May 10 - June 21, Durum from May 03 - May 19, oats from May 15 - May 24, mustard on May 29, flax from May 01 - May 25, and wheat from May 01 - May 30.

Seeding rate (B21)

Seeding rates varied considerably for most crops, as shown below:

Crop	Low (Pounds/Acre)	High (Pounds/Acre)
Barley	50	108
Canola	3	10
Durum	55	120
Oats	34	100
Mustard	8	8
Rye	84	84
Flax	28	50
W. Wheat	50	70
Sp. Wheat	45	130

Seed depth

As one would expect, seeding depth varied for each crop depending on soil moisture, soil type, texture, etc.

Crop	Minimum	Maximum
	inches	
Barley	0.5	3.0
Canola	0.1	1.5
Durum	1.5	3.0
Oats	2.0	2.5
Mustard	1.0	1.0
Rye	2.0	2.0
Flax	1.0	1.8
W. Wheat	1.5	4.0
Sp. Wheat	1.9	4.0

NOTE: One field of winter wheat in the Picture Butte area of southern Alberta was seeded into a dry seedbed at a four-inch depth in an attempt to place the seed down where there was moisture. A similar situation occurred for one field of spring wheat in the Hanna area. In both cases, respectable yields were reported although there was winterkill in the winter wheat which dropped the yield below the reported five-year average yield.

Previous season's crop

Of 172 fields, 57 were grown on fallow, three were grown on pasture or hay land that had been broken and 112 were stubbled in.

	NO. OF FIELDS GROWN			
1982 CROP	ON FALLOW	ON CEREAL STUBBLE	ON OILSEED STUBBLE	TOTAL
Barley	8	39	5	52
Canola	15	25	1	41
Durum	5	2	-	7
Oats	-	3	-	3
Mustard	1	-	-	1
Rye	-	-	1	1
Flax	2	1	1	4
W. Wheat	2	-	-	2
Sp. Wheat	24	26	11	61

Amount of trash cover

The majority of respondents reported light to medium trash cover at time of seeding.

CROP	LIGHT	MEDIUM	HEAVY
	(No. of fields)		
Barley	14	29	8
Canola	23	14	4
Durum	3	3	1
Oats	1	2	0
Mustard	1	0	0
Rye	1	0	0
Flax	2	1	1
W. Wheat	1	1	0
Sp. Wheat	25	22	13

Soil type of field

Soil type reported for fields of each crop were:

CROP	BLACK	THIN BLACK	DARK BROWN	BROWN	GREY WOODED
Barley	24	13	8	4	2
Canola	11	22	5	1	2
Durum	-	-	-	7	-
Oats	1	-	1	1	-
Mustard	-	-	-	1	-
Rye	-	1	-	-	-
Flax	-	-	3	1	-
W. Wheat	-	-	-	2	-
Sp. Wheat	8	10	29	10	3

Soil texture

The table below shows the number of fields of each crop in the survey grown on various soil textures:

CROP	SANDY	SANDY LOAM	SANDY CLAY LOAM	LOAM	CLAY LOAM	CLAY	PEATY
Barley	-	11	11	15	8	4	-
Canola	-	11	4	14	9	2	-
Durum	3	3	1	-	-	-	-
Oats	1	-	-	-	2	-	-
Mustard	-	-	1	-	-	-	-
Rye	1	-	-	-	-	-	-
Flax	-	-	-	-	2	2	-
W. Wheat	1	1	-	-	-	-	-
Sp. Wheat	2	11	13	9	17	7	-

Soil problems and severity

Respondents were asked to identify any soil problems encountered in 1982 on the fields included in the survey, as well as the severity of the problem ("0" indicated no problem while "9" was severe).

SOIL PROBLEM	SEVERITY OF PROBLEM 9	8	7	6	5	4	3	2	1	0	NO COMMENT
Solonetzic	-	1	5	-	-	3	2	8	10	93	50
Salinity	-	-	-	1	1	-	2	7	7	105	49
Acidic	-	-	1	-	3	1	2	7	1	106	51
Crusting	1	-	2	2	3	1	6	9	5	94	49
Wind erosion	-	2	-	2	5	5	8	16	5	80	48
Water erosion	-	1	-	-	-	1	5	12	13	90	50
Poor drainage	-	1	1	-	4	4	6	3	11	93	49
Micronutrient deficiency	-	-	-	1	3	3	-	3	12	83	67
Quack grass	-	-	-	1	-	-	-	-	-	-	171
Rocks	-	-	-	1	1	-	-	-	-	-	170

Average growing season rainfall for region

Respondents reported average rainfall for their region of the province ranging from five to 11 inches for Region 1, five to 13 inches for Region 2, nine to 18 inches for Region 3, eight to 14 inches for Region 4, five to 24 inches for Region 5 and eight to 12 inches for Region 6.

These ranges are not surprising since most of the regions have different climatic areas within them. For example, a respondent in the southernmost part of Region 5 may be in a very low rainfall area compared with farmers further north in the same region.

Actual growing season rainfall for region

According to the respondents, actual 1982 growing season rainfall ranged from three to 15 inches in Region 1, four to 15 inches in Region 2, 10 to 30 inches in Region 3, four to 12 inches in Region 4, three to 16 inches in Region 5 and four to 13 inches in Region 6.

Soil moisture at seeding

Seedbed moisture during 1982 in each region was classified as either dry, moist or wet, as shown below:

	REGION					
	1	2	3	4	5	6
	(No. of respondents reporting)					
Dry	2	12	8	3	4	6
Moist	22	42	25	13	17	7
Wet	2	3	4	1	0	0

Degree of seedbed firmness

The following table indicates the degree of seedbed firmness, shown as percentages of total responses to the question.

	VERY FIRM	FIRM	SLIGHTLY FIRM	SLIGHTLY LOOSE	LOOSE	VERY LOOSE
Per Cent Of Responses	7.0	21.6	24.6	35.7	9.4	1.8

Crop yield

Farmers reported a wide range in crop yields for 1982 with low yields generally resulting from drought or hail.

	YIELD (Bu/Acre)			
CROP	LOW	AVG.	HIGH	
Barley	11	76.4	99	
Canola	10	26.7	50	
Durum	19	34.3	48	
Oats	65	67.5	70	
Mustard	21	21.0	21	
Rye	25	25.0	25	
Flax	15	28.8	42	(under irrigation)
W. Wheat	33	39.0	45	
Sp. Wheat	13	36.8	73	(under irrigation)

Yield rating

Respondents were asked whether the yield they obtained, as reported above, was below average, average or above average.

CROP	BELOW	AVERAGE	ABOVE
	(No. Of respondents)		
Barley	18	12	21
Canola	12	19	9
Durum	1	2	4
Oats	1	1	1
Mustard	-	1	-
Rye	-	1	-
Flax	1	1	2
W. Wheat	-	2	-
Sp. Wheat	15	23	21

Five-Year average yield

The five-year average yield for each of the nine crops included in the survey, as reported by survey respondents, was as follows:

CROP	LOW AVG. REPORTED	AVERAGE REPORTED	HIGH AVG. REPORTED
Barley	35	61.6	80
Canola	17	28.4	38
Durum	25	30.0	39
Oats	40	57.7	85
Mustard	20	20.0	20
Rye	25	25.0	25
Flax	22	26.3	35 (under irrigation)
W. Wheat	38	38.0	38
Sp. Wheat	20	30.9	75 (under irrigation)

Degree of herbicide effectiveness

Herbicide effectiveness was rated from one to four with one being poor and four very good. The percentage of respondents indicating effectiveness in any one of these four categories was:

DEGREE OF EFFECTIVENESS	PERCENTAGE OF RESPONDENTS
1 (poor)	8
2 (fair)	21
3 (good)	44
4 (very good)	27

Reasons for poor or fair herbicide effectiveness

When asked the reasons for poor or fair herbicide effectiveness, farmers most often said that weather and soil were too dry (28 per cent of respondents), or poor choice of herbicide(s) (26 per cent). Other reasons mentioned were miscalculation of mixture and amounts to be applied, poor timing of application, excessive moisture, and rain after spraying, which produced another crop of weeds.

Several comments applied to aerial application — airplanes missing weed growth alongside trees, problem with automatic flagging, and inappropriate chemical used.

Was moisture a limiting factor and in what way?

Nearly 64 per cent of respondents said that moisture was a limiting factor in the crop yields they obtained in 1982. In explaning how moisture had had an effect, 56 per cent said that rainfall occurred at the wrong time. Most said that it was too dry to begin with and then too wet later in the season. Another 20 per cent said that drought caused poor seed development and 13 per cent blamed a very dry seedbed.

Other factors affecting yield

The questionnaire asked respondents to list other factors that may have accounted for their yields. Answers were classified as either positive or negative factors. The most common positive factors were good soil moisture, sufficient quantities of fertilizer and good varietal selection.

The most common negative factors were hail, early frost and uneven germination caused by inadequate packing.

Section IV

SURVEY RESULTS - PART C CROPPING SYSTEMS COST DATA

The final section of the questionnaire asked for data to assist in determining the costs of tilling, fertilizing, seeding and applying chemicals during 1982 for each crop referred to in the previous section.

The objective of asking for costs of production on each field was to determine if, and by how much, costs varied by the system used to accomplish each task. It was hoped that some answers could be provided for such questions as:

1. Can time and money be saved by using an airseeder for banding fertilizer and seeding?
2. How does the cost of hiring an airplane to broadcast seed or fertilizer and then incorporate the materials compare with doing these jobs with conventional ground implements, or an airseeder system?
3. How do costs compare between conventional sprayers and chemical application with airplanes?

Additionally, it was hoped that some correlation could be seen between crop yields and the systems used to produce the crop. As noted on pages 25 and 26, this did not materialize, because of the small sample size and the fact that data were for one year only and on a province-wide basis, with all the vagaries of the weather to affect yields.

Study participants were asked to list tillage, seeding, fertilizing and spraying equipment in the order in which it was used on the field, including pre-seeding tillage and fertilizing in the fall of 1981, spring operations prior to and during seeding, as well as post-seeding harrowing, spraying, etc. Sixty-five farmers supplied usable data for 172 fields.

Participants noted the implement width, its current market value, the number of times that each implement was used on the field, the type and size of tractor that pulled the implement and an estimate of labour and equipment hours associated with each field operation.

Although participants provided current market value data for each implement, along with a description of type and size of the implement, costs are based on each implement's average list price in 1982[1].

In determining annual ownership and operating costs for each tractor and implement, except for airseeders, we assumed that average annual hours of use were the same as those on which costs were determined in the publication Farm Machinery Costs (See Appendix A). Since airseeder systems are generally used in cultivation, seeding and fertilizer banding, airseeder costs are based on 200 hours of annual use rather than the hours shown in Farm Machinery Costs.

The remainder of this section of the report gives some examples of how costs compared between various systems used on Alberta farms to seed, fertilize and apply chemicals to cereals and oilseeds. The first examples illustrate cost differences where all tillage, fertilizing, seeding and chemical operations are included, followed by an examination of costs for fertilizing, seeding and chemical application costs when broken down into separate operations.

Figure II, a bar graph, shows that for 38 fields of wheat grown on stubble, 19 farmers used airseeders and 19 used conventional implements. The total number of field operations (excluding swathing and combining) for the 19 fields seeded with airseeders ranged from one (direct seeded into standing stubble) to six. For these same 19 fields, the number of tillage operations alone (where no seed, fertilizer or chemical was applied at the same time) ranged from zero (on five fields) to three (on five fields).

Where conventional implements were used on the stubbled-in wheat, the total number of field operations (again excluding swathing and combining) ranged from four (on two fields) to 11 (on one field). The number of tillage operations on the 19 fields where conventional implements were used followed almost the same pattern on the graph as the line indicating total number of field operations when airseeder systems were used, i.e. a range of from one to eight tillage operations.

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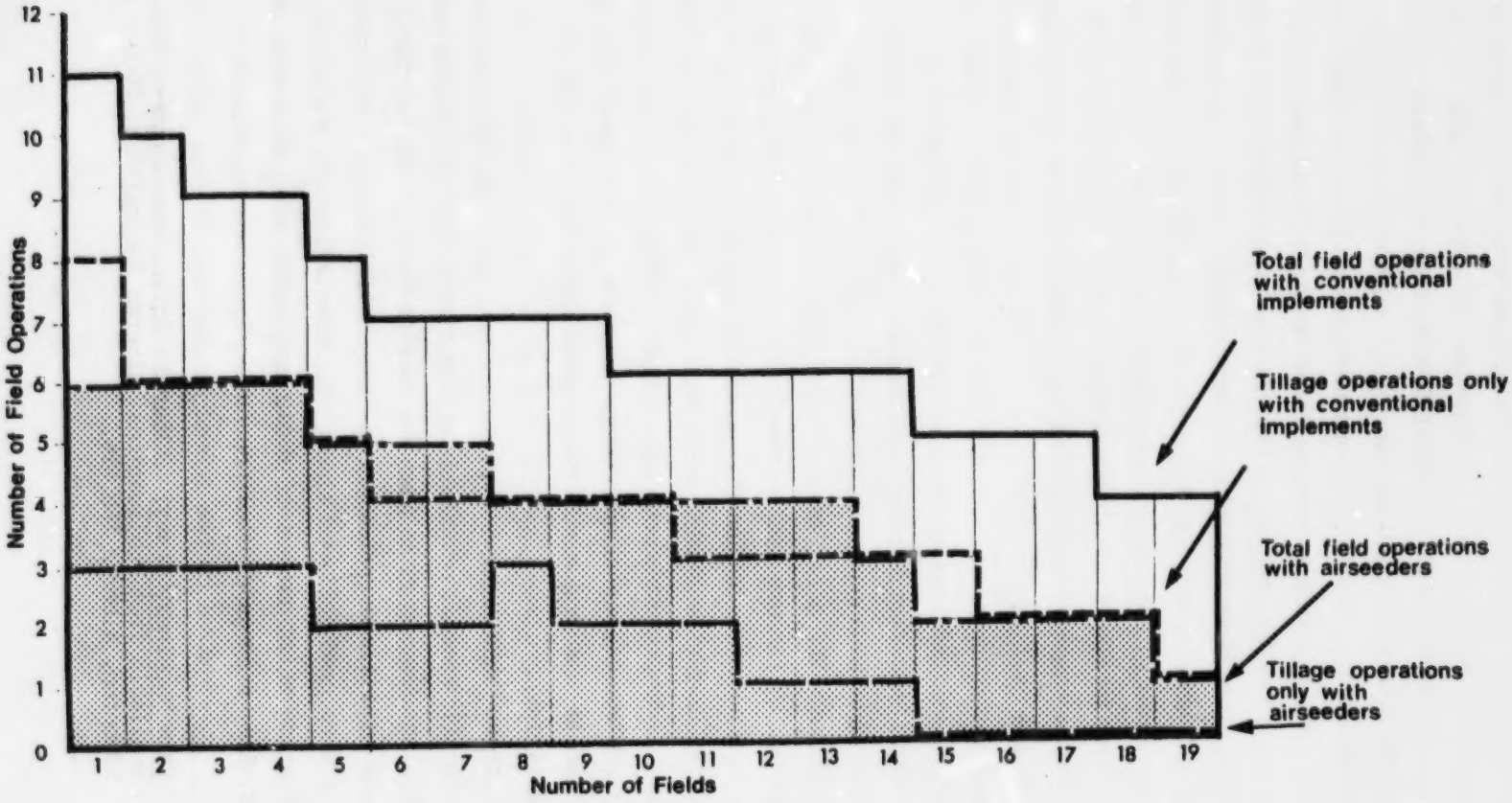
1 Farm Machinery Costs, Alberta Agriculture Agdex 825-12, 1982. Available from Publications, Alberta Agriculture, 7000 - 113 Street, Edmonton, Alberta T6H 5T6.

FIGURE II: COMPARISON OF THE NUMBER OF FIELD OPERATIONS USING AIRSEEDERS AND CONVENTIONAL IMPLEMENTS



Note: Of 38 fields of wheat grown on stubble, 19 were seeded with airseeders and 19 with conventional implements.

TABLE I: AVERAGE COST PER ACRE TO FERTILIZE, SEED AND APPLY CHEMICALS TO WHEAT ON STUBBLE USING THREE DIFFERENT FARMING SYSTEMS

	CONVENTIONAL[1]	AIRSEEDERS[1]	AIRPLANES
Number of Fields of Data	18	17	3
Average Field Size (Acres)	121	170	280
Average Times Over for Tillage Seeding, Fert. & Spraying			
Farmer	6.4	3.8	5.5
Custom Operator	.3	.4	2.0
Average Acres Tilled, Seeded, Fertilized and Sprayed Per Hour During Season	2.32	6.41	4.39
Variable Costs:			
Tractor	$8.43	$3.86	$6.40
Machinery	2.60	2.06	2.24
Labour (@$6.50/hr)	3.61	1.57	1.80
Custom	1.38	1.11	7.15
Total Variable Costs (Excluding Material Costs)	$16.02	$8.60	$17.59
Material Costs - Fertilizer	22.25	20.50	22.25
- Seed	9.02	7.52	7.95
- Chemicals	7.99	7.86	3.55
Total Material Costs	$39.26	$35.88	$33.75
Fixed Costs:			
Tractor	4.64	2.10	3.23
Machinery	5.18	4.75	3.68
Total Fixed Costs	$ 9.82	$ 6.85	$ 6.91
Total Variable and Fixed Costs	$25.84	$15.45	$24.50

1 Three fields of stubbled-in wheat are not included because of incomplete cost data.

With a seasonal average of two and one-half more passes over fields with conventional implements instead of airseeders used to grow wheat on stubble, one would expect costs to be higher, and indeed they were. Table I shows that on average, farmers were able to till, plant, fertilize and spray 6.4 acres per hour during the season with airseeder systems, compared with only 2.3 acres per hour during the season with conventional implements. Farmers who seeded with airplanes (and used airplanes for some or all of their fertilizing or spraying as well) were able to till, plant, fertilize and spray an average of 4.4 acres per hour during the season.

Labour costs were approximately $2.00 per hour greater for conventional systems than for airseeder systems and $1.80 per hour greater than for aircraft systems. Other variable costs were about $5.00 per acre more for conventional systems than for airseeder systems but $1.60 less than for airplanes. Custom application costs accounted for 40 per cent of the total variable costs incurred by farmers using airplanes.

Fixed costs (depreciation, interest, housing and insurance) amounted to $3.00 per acre more for conventional systems than for airseeders and $2.90 per acre more than for airplanes. Total variable and fixed costs for tillage, seeding, fertilizing and chemical application (excluding the costs of seed, fertilizer and chemicals) were $25.84, $15.45 and $24.50 per acre for conventional systems, airseeder systems and aircraft systems, respectively.

Although crop yields were reported for each of these fields of wheat, a correlation between yields, methods used for seeding, fertilizing and spraying, and their respective costs could not be made on the basis of the data collected. Since the data represent only 40 fields from across the entire province and include differences in weather, soil type, etc. it was impossible to say tnat any system was better than another.

Future studies of this nature will attempt to obtain yield comparisons by surveying farmers who use different systems within the same district where weather conditions will be reasonably similar.

The data in Table II are similar to that just discussed for wheat fields grown on stubble, only this table shows costs for alternative systems of seeding, fertilizing and applying chemicals on 23 fields of canola grown on stubble.

Prior to seeding canola, farmers usually work the seedbed more than with cereal crops. The 12 farmers who used conventional implements went over their fields an average of 7.2 times during the season (excluding swathing and combining). Those using airseeders went over their fields 7.6 times during the season and those using airplanes had a seasonal average of six passes over the field, including custom operations and incorporation with their own equipment. Farmers who used aircraft for seeding were able to cover the most acres per hour during the season i.e. 3.44 compared with 2.29 and 2.37 acres per hour for conventional systems and airseeder systems, respectively. Labour costs per acre were identical for conventional and airseeder systems but $1.20 per acre lower for farmers who seeded with aircraft. (Again these farmers usually also fertilized or sprayed with aircraft.) Other variable costs (excluding seed, fertilizer and chemicals) were $11.54, $14.70 and $15.28 per acre for conventional, airseeder and aircraft systems respectively, with custom application costs accounting for 37 per cent of total variable costs for aircraft systems.

Whereas farmers who used airseeder systems to produce wheat incurred lower costs than farmers using conventional equipment or aircraft, the farmers who used airseeders to produce canola had the highest costs. Fixed costs were $3.80 higher for airseeder systems than for conventional systems and $6.30 higher than for aircraft. Total variable and fixed costs (excluding the costs of materials) were $25.01, $31.95 and $25.00 per acre for conventional equipment, airseeders and airplanes.

Costs for the three systems when used to stubble-in barley (Table III) showed a pattern similar to that for wheat, although the farmers who used airseeders for barley had more passes over the field during the season than those who used airseeders for wheat. With two exceptions, farmers who used airseeders for wheat were not the same persons that used airseeders for barley. In the group that used airseeders for wheat, one farmer seeded and fertilized directly into standing stubble and four others had only two passes over their fields during the whole season.

TABLE II: AVERAGE COST PER ACRE TO FERTILIZE, SEED AND APPLY CHEMICALS TO CANOLA ON STUBBLE USING THREE DIFFERENT FARMING SYSTEMS

	CONVENTIONAL	AIRSEEDERS	AIRPLANES
Number of Fields of Data	14	5	4
Average Field Size (Acres)	88	206	399
Average Times Over for Tillage Seeding, Fert. & Spraying			
Farmer	6.9	7.2	5.0
Custom Operator	.3	.4	1.0
Average Acres Tilled, Seeded, Fertilized and Sprayed/Hour During Season	2.29	2.37	3.44
Variable Costs:			
Tractor	$7.79	$8.69	$6.75
Machinery	3.01	4.91	2.10
Labour (@$6.50/hr)	3.41	3.40	2.20
Custom	.74	1.10	6.43[1]
Total Variable Costs (Excluding Material Costs)	$14.95	$18.10	$17.48
Material Costs - Fertilizer	25.11	26.26	25.55
- Seed	2.75	2.34	3.15
- Chemicals	14.05	16.44	10.98[2]
Total Material Costs	$41.91	$45.04	$39.68
Fixed Costs:			
Tractor	4.35	4.64	3.49
Machinery	5.71	9.21	4.03
Total Fixed Costs	$10.06	$13.85	$ 7.52
Total Variable and Fixed Costs (Excluding material costs)	$25.01	$31.95	$25.00

1 Excludes $10 per acre paid by one farmer for custom applications of Benlate and Reglone.

2 Excludes $22 per acre paid by one farmer for Benlate and Reglone chemicals.

Farmers who used airplanes for barley tilled, fertilized, seeded and sprayed an average of 4.8 acres per hour during the season compared with 3.4 and 2.4 acres per hour for airseeder and conventional systems. Labour costs per acre were also least for farmers using aircraft; however, total average variable costs were $3.70 less for airseeders than for aircraft and $3.20 less than for conventional systems.

Fixed costs were the same for conventional and aircraft systems at $10.30 per acre. Fixed costs for airseeder systems were only $5.25 per acre, giving airseeders a total cost of about $8.50 per acre less than the other two systems.

To see how costs compared between systems for separate operations such as fertilizing, seeding or chemical application, data were sorted by region, operation and crop. An attempt was made to categorize the data for fields of the same crop, similar acreage and similar sized equipment. This proved to be almost impossible, placing only one or two fields in each category.

Fertilizing Costs

Calculations on the cost of fertilizing with alternative methods showed that there is a wide variation. For example, Table IV gives data for fertilizing costs for seven fields of wheat on stubble. Four fields were fertilized with banding machines (owned and rented), one with a rented anhydrous applicator, one with custom-applied granular and one with an airplane.

The banding costs ranged from $5.91 per acre for a 24 foot owned airseeder pulled with a 125 hp 2WD tractor to $9.55 per acre for a 24 foot Bandit (rented by the farmer for $4.00 per acre) and pulled with a 225 hp 4WD tractor. The cost of fertilizing with the rented anhydrous applicator was $4.18 per acre, of which the rental charge was $2.50 per acre. The custom charge for applying granular fertilizer was $2.00 per acre and the cost of aerial broadcasting fertilizer and then incorporating with ground implements was $5.73 per acre, of which $2.75 was the custom cost. Against these costs one must consider advantages of banding (higher yields and the ability to seed with the same machine in the case

TABLE III: AVERAGE COST PER ACRE, TO FERTILIZE, SEED AND APPLY CHEMICALS TO BARLEY ON STUBBLE USING THREE DIFFERENT FARMING SYSTEMS

	CONVENTIONAL	AIRSEEDERS	AIRPLANES
Number of Fields of Data	30	7	2
Average Field Size (Acres)	115	152	213
Average Times Over for Tillage Seeding, Fert. & Spraying			
Farmer	6.2	5.9	5.0
Custom Operator	.4	.3	2.0
Average Acres Tilled, Seeded, Fertilized and Sprayed/Hour During Season	2.42	3.44	4.84
Variable Costs:			
Tractor	$7.95	$5.94	$4.67
Machinery	2.82	3.62	1.44
Labour (@$6.50/hr)	3.63	2.43	1.62
Custom	1.52	.71	3.95
Total Variable Costs (Excluding Material Costs)	$15.92	$12.70	$16.43
Material Costs - Fertilizer	22.75	24.61	23.85
- Seed	7.19	5.24	8.25
- Chemicals	9.41	10.63	3.95
Total Material Costs	$39.35	$40.48	$36.05
Fixed Costs:			
Tractor	4.47	2.50	3.23
Machinery	5.84	2.74	7.07
Total Fixed Costs	$10.31	$5.25	$10.30
Total Variable and Fixed Costs	$26.23	$17.95	$26.73

TABLE IV: A COMPARISON OF FERTILIZING COSTS USING THREE METHODS (WHEAT ON STUBBLE)

AIRSEEDER SYSTEM	MACHINERY VAR$	MACHINERY FIX$	TRACTOR VAR$	TRACTOR FIX$	LABOUR $	CUSTOM $	TOT VAR $	TOT FIX $	TOTAL $
OBSERVATION									
A. 50 acres, owns 24' airseeder, 125 hp 2WD tractor, 50 lb of 34-0-0 banded, 6 hr labour	1.18	1.71	1.37	.77	.88	-	3.43	2.48	5.91
B. 100 acres, rents 24' Bandit machine @$4.00/ac, 225 hp 4WD tractor, 150 lb of 35-16-0, 15 hr labour	-	-	2.91	1.51	1.13	4.00	8.04	1.51	9.55
C. 80 acres, rents 24' banding machine @$3.50/ac, 160 hp 2WD tractor, 175 lb of 39-11-0, 10 hr labour	-	-	1.61	.90	.94	3.50	6.05	.90	6.95
D. 100 acres, owns 30' banding machine, 180 hp 4WD tractor, 10 hr labour	1.03	1.48	1.74	.97	.75	-	3.52	2.45	5.97
Average Data 82.5 acres, 25' of airseeding equipment, 173 hp tractor, 10 hr labour	.55	.80	1.91	1.04	.93	1.88	5.26	1.84	7.10

TABLE IV CONT'D: A COMPARISON OF FERTILIZING COSTS USING THREE METHODS (WHEAT ON STUBBLE)

	MACHINERY VAR$	MACHINERY FIX$	TRACTOR VAR$	TRACTOR FIX$	LABOUR $	CUSTOM $	TOT VAR $	TOT FIX $	TOTAL $
AG AIRPLANE									
OBSERVATION									
E. 315 acres, custom aerial broadcasting @$2.75/ac, incorporated fertilizer and seed with 250 hp 4WD tractor pulling 47' cult. & harrows and a 185 hp 4WD tractor pulling 63' harrow/packer (50 per cent of incorp. costs allocated to fertilizing cost)	.29	.25	1.37	.68	.39	2.75	4.80	.93	5.73
CONVENTIONAL									
OBSERVATION									
F. 160 acres, rented 45' anhydrous applicator @$2.50/acre, 160 hp 4WD, 60# N/acre, 6.5 hr labour	-	-	.91	.47	.30	2.50	3.71	.47	4.18
G. 210 acres, custom applied granular, 125 lb 34-0-0 & 40 lb 11-51-0 @$2.00/acre custom charge	-	-	-	-	-	2.00	2.00	-	2.00
Average Data 185 Acres	-	-	.46	.24	.15	2.25	2.86	.24	3.09

of an airseeder) or aerial application (getting the fertilizer on quicker, particularly in wet weather). In the case of the farmer who had granular fertilizer custom spread, it was done in the spring just before seeding so that the drill worked the fertilizer into the soil.

Seeding Costs

A comparison of costs for seeding using either conventional drills, airseeders or airplanes is shown in Table V. Data for 14 fields of wheat where six were seeded with conventional drills, six with airseeders and two with airplanes showed that, for these farmers, average variable costs (including labour and custom charges) were lowest with the airseeder systems at $4.29 per acre; almost the same at $4.33 per acre with conventional drills and $7.69 per acre for aerially seeded fields, as a result of custom broadcasting charges and incorporating the seed with ground equipment.

Average labour costs (included in the figures shown above) were least with the aerially seeded crops at $.77 per acre (the cost of incorporating the seed); almost the same, $.80 per acre, where airseeders were used and $1.11 per acre when conventional drills were used (including the labour to go over the field with harrows after seeding).

Average fixed costs (including depreciation and interest on investment) were lowest for aerially seeded fields at $3.21 per acre and highest where airseeders were used at $4.49 per acre. Conventionally seeded fields had average fixed costs of $3.25 for seeding.

Total seeding costs were highest with the airplane at $10.90 per acre and lowest with conventional systems at $7.58 per acre. Seeding costs for fields where airseeders were used were $8.78 per acre. One farmer used a 42-foot airseeder on one 420-acre field (followed by a harrow and harrow-packer operation) and a 36-foot disker on another 320-acre field which was harrowed once and harrow-packed twice (Observations L & E). His total cost with the airseeder was $6.88 per acre; the disker total cost was $6.24 per acre. The variable cost with the airseeder was $3.51 per acre ($.54 per acre for labour) and $3.44 with

TABLE V: A COMPARISON OF SEEDING COSTS USING THREE METHODS (WHEAT ON STUBBLE)

CONVENTIONAL		MACHINERY VAR$	MACHINERY FIX$	TRACTOR VAR$	TRACTOR FIX$	LABOUR $	CUSTOM $	TOT VAR $	TOT FIX $	TOTAL $
OBSERVATION										
A. 160 acres, 28' hoe press drill, 160 hp 4WD tractor, 16 hrs. labour	Seed	.97	2.34	2.12	1.10	.70	-	3.79	3.44	7.23
	Harrow 1X	.06	.33	.33	.29	.52	=	3.91	.62	1.53
		1.03	2.67	2.45	1.39	1.22	=	4.70	4.06	8.76
B. 80 acres, 21' hoe drill, 115 hp 2WD tractor, 8.5 hr labour	Seed	.86	2.21	1.25	.82	.80	-	2.91	3.03	5.94
C. 100 acres, 30' one-way (disker), 225 hp 4WD tractor, 14 hr labour	Seed	1.06	1.48	2.42	1.26	.90	-	4.38	2.74	7.12
	Harrows 2X	.12	.68	.67	.46	.75	=	1.54	1.14	2.68
		1.18	1.39	3.09	1.72	1.65	=	5.92	3.88	9.80
D. 80 acres, 30' disker, 160 hp 2WD tractor, 7 hr labour	Seed	.79	1.11	1.21	.67	.66	-	2.66	1.78	4.44
	Harrow 1X	.07	.38	.94	.53	.47	=	1.48	.91	2.39
		.86	2.06	2.15	1.20	1.13	=	4.14	2.69	6.83
E. 320 acres, 36' disker, 160 hp 4WD tractor, 16 hr labour	Seed	.64	.90	1.09	.61	.38	-	2.11	1.51	3.62
	Harrow 1X & Harrow/ Packer 2X	.17	.83	.81	.46	.35	=	1.33	1.29	2.62
		.81	1.73	1.90	1.07	.73	=	3.44	2.80	6.24
F. 80 acres, 30' duplex one-way disker, 220 hp 4WD, 7 hr labour	Seed	.73	1.02	1.67	.87	.66	-	3.06	1.89	4.95
	Harrows 2X	.10	.52	1.21	.63	.47	=	1.78	1.15	2.93
		.83	1.54	2.88	1.50	1.13	=	4.84	3.04	7.88
Average Data 137 acres, 29 ft. implement, 173 hp tractor, 11 hr labour	Seed & Incorp. 1.5X	.93	1.93	2.29	1.28	1.11	-	4.33	3.25	7.58

TABLE V CONT'D: A COMPARISON OF SEEDING COSTS USING THREE METHODS (WHEAT ON STUBBLE)

AIRSEEDER OBSERVATION		MACHINERY VAR$	MACHINERY FIX$	TRACTOR VAR$	TRACTOR FIX$	LABOUR $	CUSTOM $	TOT VAR $	TOT FIX $	TOTAL $
G. 90 acres, 41' airseeder w/harrows, 225 hp 4WD tractor, 6 hrs. labour	Seed	.87	2.08	1.60	.83	.50	-	2.97	2.91	5.88
H. 80 acres, 35' airseeder, 225 hp 4WD tractor, 7 hr labour	Seed	.62	2.18	2.37	1.26	.66	-	3.65	3.44	7.09
	Har/Pack	.45	2.27	2.04	1.12	.75	-	3.24	3.39	6.63
	Drawbar 2X	1.07	4.45	4.41	2.38	1.41	-	6.89	6.83	13.72
I. 160 acres, 31' airseeder w/harrow, 180 hp 4WD tractor, 18 hr labour	Seed	1.97	4.69	2.17	1.21	.84	-	4.98	5.90	10.88
J. 80 acres, 30' airseeder w/harrow/ packer drawbar, 185 hp 4WD, 6.75 hr labour	Seed	1.11	3.18	1.67	.87	.64	-	3.42	4.05	7.47
K. 93 acres, 27' airseeder, 186 hp 4WD, 7.3 hr labour	Seed	.97	2.31	1.61	.90	.59	-	3.17	3.21	6.38
	Rodweeder	.20	.43	.30	.20	.27	=	.77	.64	1.41
	& Double Harrows	1.17	2.74	1.91	1.11	.86	=	3.44	3.85	7.79
L. 420 acres, 42' airseeder, 350 hp 4WD, 20 hr labour	Seed	.75	1.78	1.59	.76	.36	-	2.70	2.54	5.24
	Harrow &	.11	.54	.52	.29	.18	=	.81	.83	1.64
	Har/Pack	.86	2.32	2.11	1.05	.54	=	3.51	3.37	6.88
Average Data 154 acres, 34 ft. implement, 230 hp tractor, 10.8 hr labour	Seed & Incorp. .7X	1.18	3.24	2.31	1.24	.80	-	4.29	4.49	8.78

TABLE V CONT'D: A COMPARISON OF SEEDING COSTS USING THREE METHODS (WHEAT ON STUBBLE)

AG AIRPLANE	MACHINERY VAR$	MACHINERY FIX$	TRACTOR VAR$	TRACTOR FIX$	LABOUR $	CUSTOM $	TOT VAR $	TOT FIX $	TOTAL $
OBSERVATION									
M. 315 acres, 471 HD cult & harrows, 250 hp 4WD tractor and 63' harrow packer pulled by 185 hp 4WD to incorporate fert & seed at same time (50 per cent of costs allocated to cost of incorporating seed), 16 hr labour	.77	1.78	2.73	1.35	.77	3.50	7.77	3.13	10.90
N. 245 acres, 2 X cult & harrow, pulled by 280 hp 4WD and harrow/packers pulled by 225 hp 4WD to incorporate seed, 25 hr labour	.89	1.76	2.94	1.53	.77	3.00	7.60	3.29	10.89
Average Data 280 acres	.83	1.77	2.84	1.44	.77	3.25	7.69	3.21	10.90

the disker ($.73/acre for labour). Fixed costs were $3.37 and $2.80 for the airseeder and disker systems respectively.

An analysis of the higher fixed costs with airseeder systems indicates that all the higher cost results from the airseeder itself since the fixed cost of tractors used on conventionally seeded fields is almost the same (in fact slightly higher) as the fixed cost of tractors used with the airseeder systems. The average implement width for the airseeders was 34 feet compared with 29 feet for conventional drills.

Chemical Application Costs

The study compared four methods of applying chemicals to crops: A) owned conventional ground sprayers, B) rented granular spreaders pulled with the farmer's tractor, C) custom ground application and D) custom aerial application. Table VI shows how costs compared between these four methods.

Since some chemicals are available only in liquid or only in granular form and some require incorporation while others do not, it is unfair to directly compare these methods. A direct comparison of costs of application can, however, be made between methods A and D and B and C.

The labour cost per acre for the three ground application methods ranged from $.29 to $.59. The labour cost to the farmer was nil for custom aerial spraying (except where the farmer included a cost for his own labour in flagging for the aerial applicator).

Total variable costs (including labour and custom charges, where applicable) ranged from an average of $.82 per acre for conventional ground sprayers owned by the farmer to an average of $3.06 per acre for custom aerial application of liquid chemicals. The costs of incorporating granular chemicals (using harrows or a cultivator) brought the variable costs for applying chemicals with a rented granular spreader or custom ground application to $2.53 and $2.71 per acre, respectively.

Total costs per acre (variable and fixed) were $1.31 for owned conventional sprayers and between $3.06 and $3.34 for the other three methods.

TABLE VI: AVERAGE COST PER ACRE OF FOUR METHODS OF CHEMICAL APPLICATION

	VAR.MACHINE & TRACTOR $	FIX.MACHINE & TRACTOR $	LABOUR $	CUSTOM $	TOT VAR $	TOTAL $
Owned Conventional Ground Sprayers (Plus Own Tractor)	.47	.49	.35	-	.82	1.31
Rented Granular Spreaders Plus Own Tractor & Implement for Incorporating Chemicals[1]	1.09	.82	.59	.85	2.53	3.34
Custom Ground Application of Granular Chemicals Plus Own Implement for Incorporating[1]	.69	.52	.29	1.73	2.71	3.23
Custom Aerial Application of Liquid Chemicals	-	-	-	3.06	3.06	3.06

1 Includes 50 per cent of the cost of harrowing or cultivating to incorporate chemicals, with balance of costs allocated to the tillage operation.

Any comparison of costs between alternative methods of applying chemicals (insecticides, fungicides, herbicides, etc.) should include possible hidden costs associated with timeliness, crop damage from wheel tracks, soil compaction and even the health and welfare of the applicator. If a value is placed on timeliness of operation (especially during inclement weather), not having to work with the chemicals oneself and avoiding possible wheel track damage (especially as in 1983 when many crops were well advanced before farmers could get onto the land to do their spraying following wet weather), the cost of aerial application of chemicals may be low in comparison with ground application methods.

Section V

SUMMARY AND CONCLUSIONS

Information was supplied by farmers throughout Alberta regarding their experiences with alternative methods of seeding, fertilizing and applying chemicals to 172 fields of cereal grains and oilseeds during 1982.

In addition to learning more about user likes and dislikes of conventional ground implements, airseeders and airplanes, we also determined the costs associated with these alternatives from the information supplied by each farmer.

Although there are not many farmers who use airplanes for seeding or fertilizing, and only a few of those who do were included in this study, those who regularly use airplanes to seed or fertilize are convinced of the benefits for themselves and cannot understand why more farmers don't give the system an honest try.

It appears that there are many preconceived ideas about how well any new or unusual system will perform and what the associated costs are likely to be in comparison with a more conventional system. For example, a farmer may try an airseeder system one year to seed a field and the resulting crop is a disaster. The reason for the poor crop may be that the system itself was not good, the job was done haphazardly without proper depth-monitoring, the field was not packed properly or weather conditions were extreme. Whatever the reason, there is probably a good chance that some of the neighboring farmers who watched the field after it was seeded with an airseeder will condemn an airseeder system from that point on.

The same situation occurs where airplanes are used. One bad experience, whether it was the farmer's own experience, or one of his neighbors, may eliminate the possibility of using airplanes from the minds of most farmers in the area.

In initial discussions about this study, farmers often stated that an airplane was good for spraying but too expensive for seeding or fertilizing. Some farmers also believed that an airseeder system could probably pay for itself in time-saving.

This study attempted to find out whether these beliefs were right or wrong based on a cost analysis of farmers using various systems to seed, fertilize and apply chemicals.

Although the cost analyses reported in Section IV of this publication showed lower average costs of between $8.50 and $10.40 per acre when airseeder systems were used to stubble-in barley and wheat crops, farmers who used airseeders to stubble-in canola had higher average costs of about $7.00 per acre compared with farmers who used conventional equipment or airplanes. The greater number of field operations during the season as well as larger tractors and equipment appear to be the causes of higher costs for canola crops produced with airseeder systems.

Labour cost, of course, is related to the number of field operations performed in a season. Farmers who reduce the number of field operations in a season as a result of switching to airseeders do have lower labour costs. For example, an average of 4.2 passes over a field when airseeder systems were used to grow wheat on stubble resulted in 6.4 acres per hour being tilled, fertilized, seeded and sprayed. The labour cost (at $7.00 per hour) was $1.57 per acre for these farmers. Other farmers who used conventional equipment had an average of 6.7 passes per season over their fields, resulting in only 2.3 acres per hour being tilled, fertilized, etc. and they incurred a labour cost of $3.61 per acre.

When airseeders were used to stubble-in canola, farmers performed an average of 7.6 field operations per season and their labour cost was $3.40 per acre, compared with $3.41 per acre for farmers who went over their canola fields with conventional equipment an average of 7.2 times. The average variable costs for seeding with aircraft were $3.40 per acre more than for the other two systems. Fixed costs were nearly the same as for conventional systems and $1.25 per acre less than for airseeder systems. Labour costs (part of the variable costs) associated with seeding were similar for airplanes and airseeders, and about $.30 per acre more for conventional systems. Total seeding costs were about $2.00 and $3.00 per acre more for airplanes than for airseeders or conventional equipment, respectively.

Few, if any, conclusions can be drawn regarding the cost of fertilizing with one system versus another. Hardly any two farmers used the same method to apply fertilizer. On seven fields of stubbled-in wheat,

four were fertilized with banding machines (both owned and rented), one with a rented anhydrous applicator, one with custom-applied granular fertilizer and one with an airplane. Fertilizing costs for these seven fields ranged from $2.00 per acre where 125 lb of 34-0-0 and 40 lb of 11-51-0 were custom applied, to $9.55 per acre where a farmer rented a banding machine at $4.00 per acre and used his own 225 horsepower tractor and labour. Aerially applied fertilizer cost was $5.73 per acre, right in the middle of the cost range for the seven farmers in this sample. This cost included one-half of the cost for two field operations to incorporate with harrows and harrows and packers, since aerially applied seed also needed to be incorporated at the same time.

One factor that may place the airplane at a disadvantage for fertilizing is that recent research tends to show an additional yield as a result of banding fertilizer, something that an airplane cannot achieve.

Table VI shows that custom aerial application of chemicals at about $3.00 per acre is cost competitive with ground application of granular chemicals when the cost of incorporating the chemical is considered. Where very little money is tied up in conventional ground sprayers and small tractors are used to pull the sprayers, the total cost per acre may be considerably less than the custom charge for aerial application. However, even if aerial spraying costs more than applying chemicals with ground sprayers, if one places some value on timeliness of operation, elimination of wheel damage, reduced soil compaction and avoidance of handling chemicals, aerial application may well be the best approach.

In future, economically sound crop production is likely to become more and more reliant on airplanes to apply growth regulators, pesticides and even foliar fertilizers that will provide the crop with small quantities of food several times a year.

There are many factors to consider in deciding whether an airseeder system would be worthwhile for a particular farm. This study showed that many farmers have reduced their number of field operations in a season by using an airseeder system for tillage, fertilizing and seeding. The airseeder system is obviously going to mean a reduction in fuel and labour costs, reduced wear on equipment, and a probable reduction in soil compaction, erosion and a saving of soil moisture. The farmer may also

be able to replace two, three or more conventional implements with an airseeder system since it will handle his cultivating, fertilizing and seeding.

Airseeder systems have been improving and will continue to improve at a rapid rate. The development of an electronic depth control monitor mounted on the machine itself may be a major breakthrough in overcoming one of farmers' biggest concerns about airseeders. Airseeding systems that incorporate the best features of today's airseeders but still maintain the precision of the more conventional hoe and press drills will also appear in the near future.

Along with new developments will come the need for better and more accurate information comparing crop production systems. We hope this report is a beginning.

APPENDICES

APPENDIX A

SAMPLE QUESTIONNAIRE

A COST COMPARISON OF AERIAL AND GROUND METHODS (INCLUDING AIR SEEDERS)
FOR SEEDING, FERTILIZING AND SPRAYING CEREAL AND OILSEED CROPS

FARMER SURVEY DATA

PART A

Farm Operator _____ Address _____

Phone Number _____ _____

Legal Description of Land _____

County No. _____ or M.D. No. _____ or I.D. No. _____

During the 1982 season, which method(s) were used on your farm for seeding, fertilizing and spraying cereal and oilseed crops? (Please check the appropriate boxes.)

	Conventional	Air Seeder	Aerial (Ag. Aircraft)
Seeding			
Fertilizing			
Spraying			

If you seed with conventional ground equipment, what type of drill do you use?

Double Disc Press _____ Hoe Press _____

Double Disc (no Press) _____ Hoe Drill (no Press) _____

If you use an airseeder for seeding, how is it set up (i.e. does it have press wheels, harrow - packer drawbar, etc.)? _____

If you use conventional ground equipment for fertilizing, do you have your own equipment or is the fertilizer custom applied? _____

Is nitrogen applied as anhydrous ammonia, granular, or other (please specify) _____

When is nitrogen applied (fall, spring, spring with seed)? _____

If you are using an Air Seeder on your farm, please explain why you purchased it, how long ago and why you like and/or dislike it: _____

_____

_____

_____

If you are using Ag. Aircraft to do some, or all of your farming operations, please explain why, how long you have been using aerial application and what your experiences have been with it - both good and bad, for seeding, fertilizing and spraying cereal and oilseed crops:

Seeding: _____

_____

_____

Fertilizing: _____

_____

_____

Spraying: _____

_____

_____

PART B

Please complete this page and the reverse side for one field only. Additional sheets are provided for other fields where a different crop or different variety of the same crop was grown, or where field operations were different, inputs varied, etc.)

Crop Grown in 1982 _____ Variety _____ Field Size _____ Acres

How Many Years experience do you have in growing this crop? _____

Seeding Date: _____

Seeding Rate: _____ lbs./acre

Seed Depth: _____ inches

Previous seasons crop (wheat, barley, fallow, etc.): _____

Amount of trash cover on field prior to seeding: Heavy _____ Medium _____ Light _____

Soil type of field: Black _____ Thin Black _____ Dark Brown _____ Brown _____
Grey Wooded _____

Soil texture of field: Sandy _____ Sandy Loam _____ Sandy Clay Loam _____ Loam _____
Clay Loam _____ Clay _____ Peaty (Organic) _____

Did this field have any of the following soil problems in 1982?

(Rate from "0" to "9" with "0" as 'no problem' and "9" as 'severe')

Solonetzic _____	Crusting _____	Poor Drainage _____
Salinity _____	Wind Erosion _____	Micro-Nutrient
Acidic _____	Water Erosion _____	Deficiency _____

Other (specify) _____, Rate _____

Average rainfall during growing season for your area _____ inches.

Actual rainfall during 1982 growing season _____ inches.

Soil moisture at seeding: Dry _____ Moist _____ Wet _____

How firm was the final seedbed soil just before planting?

Very firm	_____ shoe sole sinks 1/8-1/4 in.
Firm	_____ shoe sole sinks up to 1/2 in.
Slightly firm	_____ shoe sole sinks up to 3/4 in.
Slightly loose	_____ shoe sole sinks up to 1 in.
Loose	_____ shoe sole sinks up to 2 in.
Very loose	_____ shoe sole sinks up to 3 in.

Crop Yield _____ (bushels/acre)

Was this yield: average _____ above average _____ below average _____ for your farm?

What was your average yield for this crop over the last 5 years? _____ bushels/acre.

How effective were the herbicides you used on this crop:

Poor _____ Fair _____ Good _____ Very Good _____

If you rated herbicides as poor or fair, what were the reasons: _____

_____

Was moisture a limiting factor in crop yield obtained? Yes _____ No _____

If yes, explain: _____

What other factor(s) do you think accounted for the yield obtained? _____

_____

_____

_____

_____

Please specify the implements used, market value of each implement, type and size of tractor used to pull the implement, hours per acre for machine use and labour and kind, quantity and cost of seed, fertilizers and chemicals used on the field.

	FIELD OPERATIONS (Tillage, seeding, fertilizing, spraying) Implements Used Type	Width	T.O.*	Market Value	POWER SOURCE 2WD/4WD HP	TOTAL HOURS (incl. moving time) Equip.	Labour	SEED, FERTILIZER & CHEMICALS USED Kind	Qty	Cost/ Unit	Cost/ Acre	FOR OFFICE USE ONLY
PREVIOUS SEASONS '81												
PRIOR TO SEEDING '82												
SEEDING												
AFTER SEEDING												

APPENDIX B

EXAMPLES
OF
TRACTOR & MACHINERY COST CALCULATIONS

(from FARM MACHINERY COSTS publication,

AGDEX 825-12, ALBERTA AGRICULTURE, 1982)

TABLE 6

IMPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL /HR	FUEL $/ HR	LUBE $/ HR	REPAIRS */*	REPAIRS $/ YR	REPAIRS $/ HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION */*	DEPRECIATION $/ YR	DEPRECIATION $/ HR	INTEREST AVE VALUE	INTEREST $/ YR	INTEREST $/ HR	INS $/ HR	HOUSING $/ YR	HOUSING $/ HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
TRACTORS																						
2 Wheel Drive Tractors - Diesel 1/																						
PTO-HP																						
20-29	9634	400		15	1.2	1.49	0.22	42	272	0.68	2.39	81	517	1.29	3842	576	1.44	0.02	32	0.08	2.84	5.23
30-39	12638	400		15	1.7	2.07	0.31	42	357	0.89	3.28	81	679	1.70	5040	756	1.89	0.03	32	0.08	3.70	6.98
40-49	17190	400		15	2.1	2.66	0.40	42	486	1.22	4.28	81	923	2.31	6855	1028	2.57	0.04	32	0.08	5.00	9.28
50-59	19654	500		15	2.6	3.26	0.49	59	777	1.55	5.31	81	1055	2.11	7838	1176	2.35	0.04	37	0.07	4.58	9.88
60-69	23748	500		15	3.1	3.85	0.58	59	939	1.88	6.30	81	1275	2.55	9471	1421	2.84	0.05	42	0.08	5.52	11.83
70-79	26633	600		15	3.6	4.45	0.67	78	1384	2.31	7.42	81	1430	2.38	10621	1593	2.66	0.05	42	0.07	5.15	12.58
80-89	36992	600		15	4.0	5.04	0.76	78	1922	3.20	9.00	81	1986	3.31	14752	2213	3.69	0.06	42	0.07	7.13	16.13
90-99	42779	700		15	4.5	5.63	0.84	98	2801	4.00	10.47	81	2297	3.28	17060	2559	3.66	0.06	42	0.06	7.06	17.53
100-119	49715	700		15	5.5	6.81	1.02	98	3255	4.65	12.48	81	2669	3.81	19826	2974	4.25	0.07	43	0.06	8.20	20.68
120-129	54573	800		15	5.9	7.41	1.11	120	4366	5.46	13.98	81	2930	3.66	21764	3265	4.08	0.07	48	0.06	7.87	21.86
130-139	58725	800		15	6.4	8.00	1.20	120	4698	5.87	15.07	81	3153	3.94	23420	3513	4.39	0.08	48	0.06	8.47	23.54
140-149	62378	800		15	6.9	8.59	1.29	120	4990	6.24	16.11	81	3349	4.19	24876	3731	4.66	0.08	48	0.06	8.99	25.11
150-159	65453	800		15	7.3	9.18	1.38	120	5236	6.55	17.10	81	3514	4.39	26103	3915	4.89	0.08	48	0.06	9.43	26.53
160-179	72222	800		15	7.8	9.78	1.47	120	5778	7.22	18.46	81	3877	4.85	28802	4320	5.40	0.09	48	0.06	10.40	28.86
180-190	77675	800		15	8.8	10.96	1.64	120	6214	7.77	20.37	81	4170	5.21	30977	4647	5.81	0.10	48	0.06	11.18	31.56

1/ Equipped with standard transmission, Swinging drawbar, Independent dual range PTO, 75% fluid

Above 40HP with 3 point hitch, differential lock, power steering; Above 60HP 1 remote hydraulic

Above 80HP cab with heat; Above 100HP dual remote hydraulic, turbocharged

Above 120HP cab with heat & air-conditioning; Above 160HP dual rear tires

TABLE 6

IMPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL /HR	FUEL $/ HR	LUBE $/ HR	REPAIRS */*	REPAIRS $/ YR	REPAIRS $/ HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION */*	DEPRECIATION $/ YR	DEPRECIATION $/ HR	INTEREST AVE VALUE	INTEREST $/ YR	INTEREST $/ HR	INS $/ HR	HOUSING $/ YR	HOUSING $/ HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2 Wheel Drive Tractors - Front Wheel Assist - Diesel																						
PTO-HP																						
20-29	12208	400		15	1.2	1.49	0.22	42	345	0.86	2.57	81	655	1.64	4869	730	1.83	0.03	32	0.08	3.57	6.15
30-39	13353	400		15	1.7	2.07	0.31	42	378	0.94	3.33	81	717	1.79	5325	799	2.00	0.03	32	0.08	3.90	7.23
40-49	22622	400		15	2.1	2.66	0.40	42	640	1.60	4.66	81	1215	3.04	9022	1353	3.38	0.06	32	0.08	6.56	11.22
50-59	28813	500		15	2.6	3.26	0.49	59	1139	2.28	6.03	81	1547	3.09	11491	1724	3.45	0.06	37	0.07	6.67	12.70
60-69	30398	500		15	3.1	3.85	0.58	59	1202	2.40	6.83	81	1632	3.26	12123	1818	3.64	0.06	42	0.08	7.05	13.88
70-79	32502	600		15	3.6	4.45	0.67	78	1689	2.81	7.93	81	1745	2.91	12962	1944	3.24	0.06	42	0.07	6.27	14.21
80-89	44564	600		15	4.0	5.04	0.76	78	2316	3.86	9.65	81	2393	3.99	17772	2666	4.44	0.08	42	0.07	8.58	18.23
90-99	49674	600		15	4.5	5.63	0.84	78	2581	4.30	10.77	81	2667	4.44	19810	2971	4.95	0.09	42	0.07	9.55	20.32
100-119	59120	700		15	5.5	6.81	1.02	98	3871	5.53	13.36	81	3174	4.53	23577	3537	5.05	0.09	43	0.06	9.74	23.10
120-129	65304	800		15	5.9	7.41	1.11	120	5224	6.53	15.05	81	3506	4.38	26043	3906	4.88	0.08	48	0.06	9.41	24.47
130-139	67917	800		15	6.4	8.00	1.20	120	5433	6.79	15.99	81	3646	4.56	27085	4063	5.08	0.09	48	0.06	9.78	25.78
140-149	69205	800		15	6.9	8.59	1.29	120	5536	6.92	16.80	81	3715	4.64	27599	4140	5.17	0.09	48	0.06	9.97	26.77
150-159	78117	800		15	7.4	9.19	1.38	120	6249	7.81	18.38	81	4194	5.24	31153	4673	5.84	0.10	48	0.06	11.25	29.62
160-180	84083	800		15	8.1	10.08	1.51	120	6727	8.41	19.99	81	4514	5.64	33532	5030	6.29	0.11	48	0.06	12.10	32.09

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IMPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL /HR	FUEL $/ HR	LUBE $/ HR	REPAIRS */*	REPAIRS $/ YR	REPAIRS $/ HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION */*	DEPRECIATION $/ YR	DEPRECIATION $/ HR	INTEREST AVE VALUE	INTEREST $/ YR	INTEREST $/ HR	INS $/ HR	HOUSING $/ YR	HOUSING $/ HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
4 Wheel Drive Tractors - Diesel																						
Engine HP																						
70	42900	800		15	3.3	4.15	0.62	120	3432	4.29	9.06	81	2303	2.88	17109	2566	3.21	0.06	58	0.07	6.22	15.28
160-175	74658	800		15	7.9	9.92	1.49	120	5973	7.47	18.88	81	4008	5.01	29774	4466	5.58	0.10	58	0.07	10.76	29.64
176-214	84276	800		15	9.2	11.55	1.73	120	6742	8.43	21.71	81	4525	5.66	33609	5041	6.30	0.11	58	0.07	12.14	33.85
215-239	87579	800		15	10.8	13.45	2.02	120	7006	8.76	24.23	81	4702	5.88	34927	5239	6.55	0.11	60	0.07	12.61	36.84
240-260	100100	800		15	11.9	14.81	2.22	120	8008	10.01	27.04	81	5374	6.72	39920	5988	7.48	0.13	62	0.08	14.41	41.45
261-280	104296	800		15	12.8	16.03	2.40	120	8344	10.43	28.86	81	5599	7.00	41593	6239	7.80	0.14	67	0.08	15.02	43.87
281-300	108066	800		15	13.8	17.21	2.58	120	8645	10.81	30.60	81	5802	7.25	43097	6465	8.08	0.14	67	0.08	15.56	46.16
301-350	111384	800		15	15.4	19.28	2.89	120	8911	11.14	33.30	81	5980	7.47	44420	6663	8.33	0.14	70	0.09	16.04	49.34
351-470	147644	800		15	19.5	24.33	3.65	120	11812	14.76	42.74	81	7927	9.91	58880	8832	11.04	0.19	77	0.10	21.24	63.97
Garden Tractors - Gasoline																						
Geared Transmission																						
Engine HP																						
8	2680	200		12	0.6	0.76	0.11	88	197	0.98	1.85	75	167	0.84	1069	160	0.80	0.01	8	0.04	1.69	3.55
10	3538	200		12	0.7	0.95	0.14	88	260	1.30	2.39	75	221	1.11	1411	212	1.06	0.02	8	0.04	2.22	4.61
12	4017	200		12	0.9	1.14	0.17	88	295	1.48	2.79	75	251	1.26	1602	240	1.20	0.02	12	0.06	2.54	5.32
14	4245	200		12	1.0	1.33	0.20	88	312	1.56	3.09	75	265	1.33	1693	254	1.27	0.02	12	0.06	2.68	5.77
16	4455	200		12	1.2	1.52	0.23	88	327	1.64	3.39	75	278	1.39	1777	266	1.33	0.02	19	0.09	2.84	6.23

TABLE 6

IMPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL./HR	FUEL $/HR	LUBE $/HR	REPAIRS %/%	REPAIRS $/YR	REPAIRS $/HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION %/%	DEPRECIATION $/YR	DEPRECIATION $/HR	INTEREST AVE VALUE	INTEREST $/YR	INTEREST $/HR	INS $/HR	HOUSING $/YR	HOUSING $/HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
TILLAGE EQUIPMENT																						
Noble Blade																						
6' blades																						
18'	5268	160	1250	15	0.0	0.00	0.04	114	399	2.49	2.53	90	317	1.98	1521	228	1.43	0.02	83	0.52	3.95	6.49
24'	7823	160	1680	15	0.0	0.00	0.04	114	593	3.70	3.74	90	471	2.95	2259	339	2.12	0.04	90	0.56	5.66	9.41
30'	10748	160	2100	15	0.0	0.00	0.05	114	814	5.09	5.14	90	648	4.05	3104	466	2.91	0.05	90	0.56	7.57	12.71
42'	15659	160	2630	15	0.0	0.00	0.05	114	1186	7.41	7.46	90	944	5.90	4522	678	4.24	0.07	90	0.56	10.77	18.24
54'	20733	160	3620	15	0.0	0.00	0.05	114	1571	9.82	9.87	90	1249	7.81	5988	898	5.61	0.10	90	0.56	14.08	23.95
7' blades																						
21'	5509	160	1470	15	0.0	0.00	0.04	114	417	2.61	2.65	90	332	2.08	1591	239	1.49	0.03	83	0.52	4.11	6.76
28'	8244	160	1950	15	0.0	0.00	0.05	114	625	3.90	3.95	90	497	3.11	2381	357	2.23	0.04	90	0.56	5.94	9.89
35'	10528	160	2440	15	0.0	0.00	0.05	114	798	4.98	5.03	90	634	3.97	3040	456	2.85	0.05	90	0.56	7.43	12.46
49'	16196	160	3420	15	0.0	0.00	0.05	114	1227	7.67	7.72	90	976	6.10	4677	702	4.39	0.08	90	0.56	11.12	18.84
Stubble Treader																						
5'	674	160	416	15	0.0	0.00	0.03	78	35	0.22	0.25	90	41	0.25	97	15	0.09	0.00	4	0.02	0.37	0.62
6'	725	160	416	15	0.0	0.00	0.03	78	38	0.24	0.27	90	44	0.27	104	16	0.10	0.00	4	0.03	0.40	0.67
7'	752	160	416	15	0.0	0.00	0.03	78	39	0.24	0.27	90	45	0.28	108	16	0.10	0.00	5	0.03	0.42	0.69

TABLE 6

IMPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL/HR	FUEL $/HR	LUBE $/HR	REPAIRS */*	REPAIRS $/YR	REPAIRS $/HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION */*	DEPRECIATION $/YR	DEPRECIATION $/HR	INTEREST AVE VALUE	INTEREST $/YR	INTEREST $/HR	INS $/HR	HOUSING $/YR	HOUSING $/HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Rodweeder																						
trailed																						
12'	1800	120	720	15	0.0	0.00	0.05	78	94	0.78	0.83	90	108	0.90	520	78	0.65	0.01	41	0.34	1.91	2.74
14'	2400	120	850	15	0.0	0.00	0.05	78	125	1.04	1.09	90	145	1.21	693	104	0.87	0.02	48	0.40	2.49	3.58
18'	3500	120	1090	15	0.0	0.00	0.05	78	182	1.52	1.57	90	211	1.76	1011	152	1.26	0.02	63	0.53	3.57	5.14
24'	4500	120	1450	15	0.0	0.00	0.05	78	235	1.95	2.00	90	271	2.26	1300	195	1.62	0.03	84	0.70	4.61	6.62
30'	5800	120	1820	15	0.0	0.00	0.05	78	302	2.52	2.57	90	350	2.91	1675	251	2.09	0.04	84	0.70	5.74	8.31
36'	6300	120	2180	15	0.0	0.00	0.05	78	328	2.74	2.79	90	380	3.16	1819	273	2.27	0.04	84	0.70	6.18	8.96
48'	11400	120	2420	15	0.0	0.00	0.05	78	594	4.95	5.00	90	687	5.73	3292	494	4.12	0.07	84	0.70	10.61	15.61
trailed - with multiplex																						
12'	2855	120	720	15	0.0	0.00	0.05	78	149	1.24	1.29	90	172	1.43	825	124	1.03	0.02	41	0.34	2.82	4.11
14'	3090	120	850	15	0.0	0.00	0.05	78	161	1.34	1.39	90	186	1.55	892	134	1.12	0.02	48	0.40	3.09	4.48
16'	4130	120	970	15	0.0	0.00	0.05	78	215	1.79	1.84	90	249	2.07	1193	179	1.49	0.03	55	0.46	4.05	5.89
18'	4300	120	1090	15	0.0	0.00	0.05	78	224	1.87	1.92	90	259	2.16	1242	186	1.55	0.03	63	0.53	4.26	6.18
24'	6187	120	1450	15	0.0	0.00	0.05	78	322	2.69	2.74	90	373	3.11	1787	268	2.23	0.04	84	0.70	6.08	8.82
30'	7753	120	1820	15	0.0	0.00	0.05	78	404	3.37	3.42	90	467	3.89	2239	336	2.80	0.05	84	0.70	7.44	10.86
36'	8505	120	2180	15	0.0	0.00	0.05	78	443	3.69	3.74	90	513	4.27	2456	368	3.07	0.05	84	0.70	8.09	11.84
48'	14045	120	2420	15	0.0	0.00	0.05	78	732	6.10	6.15	90	846	7.05	4056	608	5.07	0.09	84	0.70	12.91	19.06
60'	17420	120	2660	15	0.0	0.00	0.05	78	908	7.57	7.62	90	1050	8.75	5031	755	6.29	0.11	84	0.70	15.85	23.46

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COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Rodweeder Attachment to cultivator																						
Hydraulic lift																						
10'	599	120	470	15	0.0	0.00	0.04	78	31	0.26	0.30	90	36	0.30	173	26	0.22	0.00	0.00	0.52	0.82
12'	645	120	560	15	0.0	0.00	0.04	78	34	0.28	0.32	90	39	0.32	186	28	0.23	0.00	0.00	0.54	0.86
14'	651	120	650	15	0.0	0.00	0.04	78	34	0.28	0.32	90	39	0.33	188	28	0.24	0.00	0.00	0.57	0.89
16'	702	120	740	15	0.0	0.00	0.04	78	37	0.30	0.34	90	42	0.35	203	30	0.25	0.00	0.00	0.61	0.96
18'	744	120	840	15	0.0	0.00	0.04	78	40	0.33	0.37	90	46	0.38	221	33	0.28	0.00	0.00	0.66	1.04
20'	1145	120	930	15	0.0	0.00	0.04	78	60	0.50	0.54	90	69	0.58	331	50	0.41	0.01	0.00	1.00	1.53
22'	1196	120	1030	15	0.0	0.00	0.04	78	62	0.52	0.56	90	72	0.60	345	52	0.43	0.01	0.00	1.04	1.60
24'	1258	120	1120	15	0.0	0.00	0.04	78	66	0.55	0.59	90	76	0.63	363	54	0.45	0.01	0.00	1.09	1.68
26'	1264	120	1210	15	0.0	0.00	0.04	78	66	0.55	0.59	90	76	0.63	365	55	0.46	0.01	0.00	1.10	1.69
28'	1315	120	1300	15	0.0	0.00	0.04	78	69	0.57	0.61	90	79	0.66	380	57	0.47	0.01	0.00	1.14	1.75
30'	1344	120	1400	15	0.0	0.00	0.04	78	71	0.59	0.63	90	82	0.69	395	59	0.49	0.01	0.00	1.19	1.82
32'	1417	120	1470	15	0.0	0.00	0.04	78	74	0.62	0.66	90	85	0.71	409	61	0.51	0.01	0.00	1.23	1.89

TABLE 6

INPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	VARIABLE COSTS: FUEL GAL /HR	FUEL $/ HR	LUBE $/ HR	REPAIRS */*	REPAIRS $/ YR	REPAIRS $/ HR	TOTAL PER HOUR	FIXED COSTS: DEPRECIATION */*	DEPRECIATION $/ YR	DEPRECIATION $/ HR	INTEREST AVE VALUE	INTEREST $/ YR	INTEREST $/ HR	INS $/ HR	HOUSING $/ YR	HOUSING $/ HR	TOTAL PER HOUR	TOTAL COSTS PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PLANTING																						
End Wheel Drill with marker disc, acre meter																						
10 '	7920	100	360	15	0.0	0.00	0.05	67	354	3.54	3.59	90	477	4.77	2287	343	3.43	0.06	43	0.43	8.69	12.28
12 '	8857	100	440	15	0.0	0.00	0.05	67	396	3.96	4.01	90	534	5.34	2558	384	3.84	0.07	49	0.49	9.73	13.74
13 '	9225	100	470	15	0.0	0.00	0.05	67	412	4.12	4.17	90	556	5.56	2664	400	4.00	0.07	56	0.56	10.19	14.36
14 '	10426	100	510	15	0.0	0.00	0.05	67	466	4.66	4.71	90	628	6.28	3011	452	4.52	0.08	63	0.63	11.51	16.22
Press Drill with double disc																						
8 '	9520	100	290	15	0.0	0.00	0.05	67	426	4.26	4.31	90	574	5.74	2749	412	4.12	0.07	36	0.36	10.29	14.60
10 '	11050	100	360	15	0.0	0.00	0.05	67	494	4.94	4.99	90	666	6.66	3191	479	4.79	0.08	43	0.43	11.96	16.95
12 '	12000	100	425	15	0.0	0.00	0.05	67	537	5.37	5.42	90	723	7.23	3466	520	5.20	0.09	48	0.48	13.00	18.42
14 '	14307	100	480	15	0.0	0.00	0.05	67	640	6.40	6.45	90	862	8.62	4132	620	6.20	0.11	63	0.63	15.56	22.00
with hoe opener																						
8 '	8251	100	290	15	0.0	0.00	0.05	67	369	3.69	3.74	90	497	4.97	2383	357	3.57	0.06	36	0.36	8.97	12.71
10 '	8760	100	360	15	0.0	0.00	0.05	67	392	3.92	3.97	90	528	5.28	2530	379	3.79	0.07	43	0.43	9.57	13.54
11 '	10217	100	420	15	0.0	0.00	0.05	67	457	4.57	4.62	90	616	6.16	2951	443	4.43	0.08	53	0.53	11.19	15.81
12 '	10829	100	440	15	0.0	0.00	0.05	67	484	4.84	4.89	90	653	6.53	3127	469	4.69	0.08	56	0.56	11.86	16.75
14 '	12228	100	510	15	0.0	0.00	0.05	67	547	5.47	5.52	90	737	7.37	3531	530	5.30	0.09	63	0.63	13.39	18.91
18 '	13400	100	650	15	0.0	0.00	0.05	67	599	5.99	6.04	90	808	8.08	3870	580	5.80	0.10	76	0.76	14.74	20.78

TABLE 6

					VARIABLE COSTS							FIXED COSTS									TOTAL
					FUEL		LUBE	REPAIRS			TOTAL	DEPRECIATION			INTEREST			INS	HOUSING		TOTAL	COSTS
INPLEMENT	AVE LIST PRICE	ANNUAL USE HRS	ANNUAL USE ACRES	EST LIFE YRS	GAL /HR	$/ HR	$/ HR	•/•	$/ YR	$/ HR	PER HOUR	•/•	$/ YR	$/ HR	AVE VALUE	$/ YR	$/ HR	$/ HR	$/ YR	$/ HR	PER HOUR	PER HOUR
COL. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Air Seeders [1]																						
With Field Cultivator																						
28'	29000	100	1670	15	0.0	0.00	0.05	67	1297	12.97	13.02	90	1748	17.48	8375	1256	12.56	0.22	88	0.88	31.14	44.15
42'	35000	100	3612	15	0.0	0.00	0.05	67	1565	15.65	15.70	90	2109	21.09	10108	1516	15.16	0.26	88	0.88	37.40	53.10
With Chisel Plow																						
35'	44074	100	2170	15	0.0	0.00	0.05	67	1970	19.70	19.75	90	2656	26.56	12729	1909	19.09	0.33	88	0.88	46.87	66.62
40'	46620	100	2480	15	0.0	0.00	0.05	67	2084	20.84	20.89	90	2810	28.10	13464	2020	20.20	0.35	88	0.88	49.52	70.42
air seeder only																						
Pulled Between Implement and Tractor [2]																						
36'	24019	100		15	0.0	0.00	0.04	67	1074	10.74	10.78	90	1448	14.48	6937	1041	10.41	0.18	43	0.43	25.49	36.27
Pulled Behind Implement																						
40'	26484	100		15	0.0	0.00	0.04	67	1184	11.84	11.88	90	1596	15.96	7649	1147	11.47	0.20	43	0.43	28.06	39.94
60'	29248	100		15	0.0	0.00	0.04	67	1308	13.08	13.12	90	1763	17.63	8447	1267	12.67	0.22	43	0.43	30.95	44.06

[1] Including boots, hoses, mounting equipment, proportionator

[2] 20' to 48' available with minimal cost difference